Coastal Benthic Optical Properties (CoBOP) of Coral Reef Environments: Effects of Changes in the Spectral Quality and Quantity of the Underwater Light Field and Elevated Temperatures on Small Scale (0.01 to 0.1 m) Optical Properties of Corals

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LONG-TERM GOAL

My principal goal is to understand the mechanistic basis for changes in the flourescent signatures, both host and algal symbiont, of corals. Changes in the spectral quantity and quality of visible and ultraviolet radiation will have effects of the quantum yield of photosynthesis and affect the fluorescent signatures of the algal symbionts as will changes in the temperature of the surrounding seawater. Since the reef environment is very dynamic, the challenge is to understand what environmental factors are responsible for the the greatest variability in these fluorescent optical signatures at small to large scales and understand sufficiently to model them over spacte and time.

OBJECTIVES

The Coastal Benthic Optical Properties (CoBOP) project is directed at understanding the optical properties of coastal benthic communities in general, and in particular, coral reefs. Coral reef communities are coastal areas of high water transparency which make them ideal systems to study optical signatures originating from the benthos. The scientific objectives of my project are:

1. to attain optical closure for coral reef communities
2. to understand the causes of benthic optical variability
    a. determine the spectral signatures of reef organisms

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b. determine the effects of the physical environment on the physiology of reef organisms and assess those effects on optical signatures

c. identify the temporal and spatial scales of variability in these optical signatures

d. to help evaluate the use of underwater systems to quantitatively measure fluorescent optical signatures

APPROACH

Studies were conducted in August 1995 on Long Key Reef at 10 m depth in the Dry Tortugas, Florida and 18 m off of Loggerhead Key, Dry Tortugas in June 1996. During these cruises I was able to measure photosynthesis and fluorescence of two species of reef forming corals (*Montastraea faveolata* and *Montastrea cavernosa* at 10 and 18 m). This data is presently being compiled into a multi-authored manuscript for submission Limnology and Oceanography. I have a close working association with Drs. Charlie Mazel and Charles Yentsch, and Dave Phinney on this project and the manuscript described above. The present award includes the measurement of primary productivity, measurement of ambient and underwater visble and ultraviolet radition, pigment analyses by HPLC, flourescent signatures using *in situ* (*e.g.*, FRRF) and laboratory based techniques, the molecular genetics of the algal symbionts, the small scale optical properties of coral polyps, and the charcterization of the benthic coral reef community using photographic quadrat techniques.

WORK COMPLETED

In the first year of this proposal the CoBOP program was able to establish its long-term research site on Lee Stocking Island in the Bahamas. During the site visit an underwater fast-repition rate fluorometer was tested in shallow waters. Additionally, the techniques to measure photosynthetic pigments by HPLC, and conduct the molecular genetics characterization of the host and zooxanthellae were established in my laboratory. Lastly, I am presently working on a new laboratory based spectroradiometer system that will provide measurements on the reflection, absorption, and fluorescence of light at the

level of the poly in corals. This information will be used to model the optical properties of the coral poly with the help of Dr. Robert Maffione.

RESULTS

This particular iteration of the underwater FRRF, although able to obtain usable results when tested in the Bahamas, proved to be cumbersome underwater. I have provided this information to Dr. Paul Falkowski and his staff in several conversations which is leading to design improvements presently being undertaken in Dr. Falkowskiš laboratory. We anticipate the a final version of the underwater FRRF will be ready for the Spring 1998 cruise to the Bahamas. The technical difficulties of analyzing photosynthetic pigments by HPLC have been worked out and a set of HPLC standards (same standards used for JGOFS and SEAWIFFS) for most of the commonly occurring pigments has been obtained and used successfully. The protocols for obtaining DNA from both the host and symbionts of corals has also been established in my laboratory. I will be using previously determined PCR primers to amplify small subunit ribosomal RNA for RFLP analysis or sequencing to determine the population of zooxanthllae genotypes in the corals used for this project.

IMPACT/APPLICATIONS

Two specific impacts of the work completed to date are the refinement of the underwater FRRF for obtaining fluorescent signatures in situ and using this instrumentation as a tool to detect whether corals have been exposed to environmental stress that might lead to bleaching or mortality. Secondly, understanding the genotype component of the corals under study will allow us to partition out another source of potential variation in the optical signatures being measured.

TRANSITIONS

The data collected from the 1996 and 1996 field seasons is presently being prepared for publication. In that process other members of the CoBOP team will be able to utilize a complete data set on two species of coral at two depths to look at factors influencing the optical properties of those corals. Information from year one of the present award is

already being used to improve instrumentation that will be used in the next 2-3 years in the field.

RELATED PROJECTS

Charlie Mazel-ONR, CoBOP

Chalie Yentsch-ONR, CoBOP

Dave Phinney-ONR, CoBOP

Paul Falkowski-ONR, CoBOP

REFERENCES

M. P. Lesser, C. Mazel, C. Yentsch, and D. Phinney. Benthic Optical Properties of Coral Reefs: Effects of Changes In The Spectral Quality and Quantity of the Underwater Light Field on Productivity and Fluorescence Yields of Hermatypic Corals. (Manuscript in preparation for Limnology and Ocenaography)

http://nightsea.mit.edu/research/cobop/lsi/lsi.html